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ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES--FLAT GLASS INDUSTRY

ARTHUR D. LITTLE, INCORPORATED

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

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This study supplies the Environmental Protection Agency with an analytical framework for determining the economic impact of water pollution control requirements and water effluent standards upon the flat glass industry. The industry was segmented into sectors; Sheet Glass (SIC 3211), Plate Glass (SIC 3211), Float Glass (SIC 3211), Laminated Glass (SIC 3231), and Tempered Glass (SIC 3211). There were no plant closings, the expected price increase for BPT is less than o.1% and less than o.3% for BAT.

The expected capital investment required for pollution control be $1,133,000 for BPT, $5166,000 for BAT. The expected annualized cost (including operating, maintenance, and capitalization of the investment will be $447,000 for BPT and $1,409,000 for BAT.

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ECONOMIC ANALYSIS

OF

EFFLUENT GUIDELINES

FLAT GLASS INDUSTRY

Report to

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Planning and Evaluation
Washington, D.C. 20460

August 1974

PREFACE

The attached document is a contractor's study prepared with the supervision and review of the Office of Planning and Evaluation of the U.S.Environmental Protection Agency (EPA). Its purpose is to provide a basis for evaluating the potential economic impact of effluent limitations guidelines and standards of performance estabished by EPA pursuant to sections 304(b) and 306 of the Federal Water Pollution Control Act.

The study supplements an EPA technical "Development Document" issued in conjunction with the promulgation of guidelines and standards for point sources within this industry category. The Development Document surveys existing and potential waste treatment and control methods and technologies within this category and presents the investment and operating costs associated with various control technologies. This study supplements that analysis by estimating the broader economic effects (including product price increases, continued viability of affected plants, employment, industry growth and foreign trade) of the required application of certain of these control technologies.

This study has been submitted in fulfillment of Contract No. 68-01-1541, Task No. 34 by Arthur D. Little, Inc. Work was completed as of August 1,1974. The study is based primarily upon an earlier study, also prepared by Arthur D. Little, Inc., entitled "Economic Analysis of Proposed Effluent Guidelines for Flat Glass Industry." The earlier report was circulated in conjunction with the publication of the Federal Register of a notice of proposed rulemaking under sections 304(b) and 306 for the subject point source category. The analysis contained in the original study has been updated based upon information received during the period of time between publication of the notice of proposed rulemaking and the promulgation of the final regulation. Because of the constraints of time, the control and treatment costs analyzed in this study may not in all instances be identical to those associated with the requirements of the promulgated regulation. However, those differences, when they exist are minor insofar as the final conclusions of the study are concerned.

This report represents the conclusions of the contractor. It has been reviewed by the Office of Planning and Evaluation and approved for publication. Approval does not signify that the contents necessarily reflect the views of the Environmental Protection Agency. The study has been considered, together with the Development Document, information received in the form of public comments on the proposed regulation, and other materials in the establishment of final effluent limitations guidelines and standards of performance.

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EXECUTIVE SUMMARY

I. INTRODUCTION

The objective of this study is to provide an analysis of the economic impact of the water pollution control requirements anticipated under the Federal Water Pollution Control Amendments of 1972. The impact was analyzed for three levels of treatment:

- Best Practicable Technology available (B.P.T.) - to be met by industrial dischargers by 1977
- Best Available Technology economically achievable (B.A.T.) - to be met by 1983
- New Source Performance Standards (N.S.P.S.) - to be applied to all new facilities that discharge directly to navigable waters and constructed after the promulgation of guidelines.

Specifically the economic impacts analyzed are:

- Price
- Profitability, growth and capital availability
- Employment
- Community
- Balance of Payments
- Related Industries

The information and data base for carrying out this analysis were developed primarily from three sources: 1) information in the effluent guideline development document on the flat glass industry, 2) our background, knowledge and experience with the flat glass industry, and 3) assistance of certain participating companies in the industry and other external sources.

II. METHODOLOGY

In the first phase of this study the flat glass industry was divided into industrial segments which differentiated the industry by technology, products, end-use applications, and markets. In each segment the production techniques and technologies were documented: market size and trends, price history and pricing policies and product distribution determined, participating companies

and the financial characteristics of these companies identified, and characterization of existing plants in terms of size, employment, etc. was carried out.

At the conclusion of Phase I and with the aid of information supplied by the Contractor of the Effluent Guideline Development Study, those segments that are most likely to be significantly impacted were defined.

In Phase II of this study, those segments of the flat glass industry which appeared from the first phase work to be most severely affected by the cost of controls were analyzed for the magnitude of the impact. In this phase the cost information generated in the Effluent Guideline Development Study was used as the basis of the analysis. The anticipated guidelines and associated cost were reviewed with the management of representative firms for reaction and discussion. Independently these costs were translated into unit cost and compared with existing unit prices. The anticipated investment required to meet the three levels of abatement was also analyzed relative to existing investment and our estimate of the ability of industry to meet these additional costs. Consideration was given to the present and projected economic state of the various industry segments and conclusions drawn as to the effects of additional cost on price, profitability, employment, etc.

III. SEGMENTATION

Initially this study of the economic impact of water pollution control on the flat glass industry was limited to three major segments of primary glass production: 1) sheet glass, 2) plate glass, 3) float glass. The remaining segment of the primary flat glass manufacturing, rolled and polished glass, was excluded on the basis that it represented a relatively minor fraction of the total glass industry.

It became evident at the conclusion of Phase I and with support of preliminary data from the Effluent Guideline Development Study that relatively minor waste water effluent problems existed within the sheet and float glass segments of the industry and the costs associated with meeting anticipated

guidelines were small. However, it was evident that relatively greater problems and cost might be involved in the industrial segments of 1) automotive glass tempering, and 2) automotive glass lamination.

It was appropriate then that the Phase II study concentrate on these two segments of automotive glass fabrication. Therefore, Phase II of this study focused heavily on developing the necessary information and analyzing the impact of water pollution control on these latter two industry segments.

IV. COSTS

The cost data used as a basis of analysis in this study were taken from the Effluent Guideline Development Document on the flat glass industry. Operating costs and investment requirements for each level of control were selected on the basis of the anticipated guidelines recommended. These data are summarized in Table S-1.

Manufacturing cost data are not available for the large number of products of these industry segments. We found that understandably, participating companies are reluctant to provide such data; therefore, we have used average prices as a basis for comparison in the study.

V. FINANCIAL PROFILE

Table S-2 displays the significant financial data for the publicly held U.S. flat and automotive glass producers. Most of these companies are fully integrated, multiproduct and multi-industry participants with significant positions in the U.S. economy. Glass sales naturally represent a greater proportion of the sales of the smaller companies such as Shatterproof, Guardian and ASG, but is still a significant portion of LOF's and PPG's total business. Data is unavailable for Ford's glass business which is a small proportion of Ford's total business. Financial data on private companies (Safetee, Safelite) are also unavailable.

TABLE S-1

SUMMARY OF ANTICIPATED INVESTMENTS AND ANNUAL OPERATING COSTS FOR TYPICAL PLANTS
($000)

Segment	Plant Size	B.P.T. Investment	B.P.T. Annual Operating Cost	B.A.T. Investment	B.A.T. Annual Operating Cost	N.S.P.S. Investment	N.S.P.S. Annual Operating Cost
Sheet		--	--	--	--	--	--
Float	400,000 tons	no cost		52	16	52	16
Plate	165,000 tons	57	32.8	656	138.3	656	138.3
Tempered	37.5 MMSF	81	24.1	149	42.1	149	42.1
Laminated	8.0 MMSF	32	14.6	115	32.8	115	32.8

Source: Effluent Guideline Development Document

TABLE S-2

1973 FINANCIAL DATA - FLAT AND AUTOMOTIVE GLASS MANUFACTURERS
($ Values in Millions)

	Basis for Year End	Net Sales	Net Earnings	Working Capital	Share-holders' Equity	Return on Equity	Glass Net Sales	Glass Earnings Before Taxes	Glass Sales as % of Total Sales
PPG Industries	Dec. 31	1512.6	104.4	393.1	802.6	13.0	665.5	51.2	44.0
Ford Motor Company	Dec. 31	23015.1	906.5	1660.5	6405.1	14.2	N.A.	N.A.	N.A.
Libbey-Owens-Ford	Dec. 31	689.2	62.2	113.2	370.3	16.8	463	48.5	67.2
American Saint-Gobain	Dec. 31	67.3	2.9	24.9	25.5	11.4	N.A.	N.A.	~95.0
Guardian Industries	Dec. 31	87.2	9.2	14.8	32.8	28.0	75.1	8.1	86.1
Combustion Engrg.	Dec. 31	1272.7	43.6	148.8	321.1	13.4	N.A.	N.A.	N.A.
Shatterproof Glass	Oct. 31	45.2	(0.1)	15.3	22.9	(0.4)	45.2	(0.1)	100.0

Source: 1973 Company Annual Reports and Contractor estimates.

VI. IMPACTS

Based on information generated in this study the economic impact of the cost of meeting the anticipated water pollution guidelines for the three levels of treatment are summarized below. The cost and effect on present prices for each segment are summarized in Table S-3.

- Sheet Glass

In the manufacture of sheet glass products, no process waste waters are involved; therefore, no waste water or waste load need be treated and none should be discharged.

In the light of these findings no additional costs are anticipated for sheet glass manufacturing operations and there will be no corresponding impact on price, profitability, production curtailment, employment or related community effects. These conclusions apply to all three levels of treatment.

- Float Glass

To meet the B.P.T. level of treatment no additional costs are required and therefore no economic impact in price, production, profitability, employment, etc., will result.

The cost and investment of control technology for B.A.T. level of treatment in a float glass operation are minimal. Considering the healthy state of this segment of the industry no economic impacts are anticipated.

The proposed limit for new sources of flat glass manufacturing is the same as for B.A.T. Considering the substantial investment required for new float glass facilities, the incremental investment will not impose restrictions on future plant construction.

- Plate Glass

The anticipated economic effect of water pollution control treatment on the plate glass manufacturing segment of the industry will be minimal. The conclusions are based on two factors: a) the incremental costs to meet either

TABLE S-3

SUMMARY OF INCREMENTAL UNIT COSTS TO MEET PROPOSED 1977 AND 1983 GUIDELINES

Segment	Present Average Price	Incremental Cost To Meet B.P.T. (1977)	% of Present Price	Incremental Cost To Meet B.A.T. (1983)	% of Present Price
Float	--	No Cost	--	Neg.	--
Plate	$0.13/lb	0.01¢/lb	0.1	0.04¢/lb	0.3
Tempered	$0.50/SF	0.06¢/SF	0.1	0.11¢/SF	~ 0.2
Laminated	$1.50-1.80/SF	0.18¢/SF	< 0.1	0.41¢/SF	~ 0.2

B.P.T. (1977) or B.A.T. (1983) are small, and b) continuation of the manufacture of glass by the plate process will be limited by other factors, i.e., the replacement by float glass operations. Due to the noncompetitive nature of plate glass manufacturing, future construction of plate glass plants will not take place and new sources treatment will not be a consideration.

- Solid Tempered Automotive Glass

The incremental cost of meeting the proposed B.P.T. (1977) for tempered automotive glass represents approximately 0.1% of present average prices. It was concluded that this incremental cost will be passed on by the glass fabricator and therefore would have no negative effects on current rates of profitability. The required investment will be available on a plant-by-plant and company-by-company basis and in no way restricts production or expansion.

It is further concluded that incremental costs to meet B.A.T. treatment (1983) will be small (less than 0.2% of present prices) and this small increase will be passed on by the fabricator. Therefore no impacts are anticipated.

The proposed control technology for new sources of tempered automotive glass are identical with those for B.A.T. (1983) and therefore will impose no negative economic factors on the industry.

- Laminated Windshield Fabrication

The unit costs for meeting the proposed B.P.T. and B.A.T. guidelines are 0.18¢/SF and 0.41¢/SF, respectively. This incremental cost represents less than 0.1% of the present price of laminated windshields in the former case and less than 0.2% for the latter. Thus it is concluded that the cost resulting from the recommended control and treatment technologies will have little or no economic effect on the laminated windshield fabrication industry. Any incremental cost will be passed on and thus no negative effect on profitability or plant operations are anticipated. The required capital will be available to meet these costs. The proposed requirements for new sources are identical with those proposed for B.A.T. (1983) and therefore the conclusions will not be altered for new plants.

VII. LIMITATIONS

In arriving at the conclusions of this analysis certain assumptions about the economy have been made such as the rate of growth of the Gross National Product. Constant 1973 dollars for all future expenditures have also been assumed.

Specifically, the conclusions in this study are based on the guidelines as proposed in the Effluent Guideline Development Document, the associated technology to meet these limits, and the related cost. If the assumptions in deriving these costs or the effluent requirements are changed as to require different technologies, then the conclusions of this study may not necessarily be valid.

We believe that this analysis as presented represents an accurate description of the economic effect of the cost of pollution on this industry. There are other factors operating within the industry such as the replacement of much of the present sheet glass capacity with float that probably are overriding factors in decisions to close certain operations and expand others.

INDUSTRY SUMMARY - PLATE GLASS

Industry - Plate Glass
SIC Code - 3211

# Plants in segment	3
% Total plants in industry	5.5%
# Plants direct discharging	0
% Total plants in segment	-
# Plants with BPT treatment in place	0
% Total plants in segment	-

	B.P.T.	B.A.T.
COST OF POLLUTION ABATEMENT		
Capital costs for segment		
Total capital cost	170,000	1,960,000
Total capital expenditures as % of average annual investment	10%	110%*
Total capital expenditures as % of total capital in place	N.A.	N.A.
Annualized costs for segment		
Total incremental increase including capital charges	96,000	415,000
Total incremental increase excluding capital charges	74,000	159,000
Total incremental increase including capital charges as % of sales	0.1%	0.3%
EXPECTED PRICE INCREASE		
Expected increase due to pollution control	0.1%	0.3%
PLANT CLOSURES		
Total closures anticipated	None	None
% reduction of segment capacity due to closures	-	-

*Due to the small annual investments, largely for modifications, in plate glass facilities over past several years.

	B.P.T.	B.A.T.
EMPLOYMENT		
Total # of employees affected	None	None
% of total employees in segment	-	-
COMMUNITY EFFECTS	None	None
IMPACT ON INDUSTRY GROWTH	None	None
BALANCE OF TRADE EFFECTS	None	None

INDUSTRY SUMMARY - FLOAT GLASS

Industry - Float Glass
SIC Code - 3211

# Plants in segment	15
% Total plants in industry	27%
# Plants direct discharging	9
% Total plants in segment	60%
# Plants with BPT treatment in place	15
% Total plants in segment	100%

	B.P.T.	B.A.T.
COST OF POLLUTION ABATEMENT		
Capital costs for segment		
Total capital cost	0	416,000
Total capital expenditures as % of average annual investment	-	1.4%
Total capital expenditures as % of total capital in place	-	∿ 0.1%
Annualized costs for segment		
Total incremental increase including capital charges	0	134,000
Total incremental increase excluding capital charges	-	93,000
Total incremental increase including capital charges as % of sales	-	Neg.
EXPECTED PRICE INCREASE		
Expected increase due to pollution control	-	None
PLANT CLOSURES		
Total closures anticipated	-	None
% reduction of segment capacity due to closures	-	-

	B.P.T.	B.A.T.
EMPLOYMENT		
Total # of employees affected	-	None
% of total employees in segment	-	-
COMMUNITY EFFECTS	-	None
IMPACT ON INDUSTRY GROWTH	-	None
BALANCE OF TRADE EFFECTS	-	None

INDUSTRY SUMMARY - LAMINATED GLASS

Industry - Laminated Glass
SIC Code 3231

# Plants in segment	12
% Total plants in industry	72%
# Plants direct discharging	9
% Total plants in segment	70%
# Plants with BPT treatment in place	N.A.
% Total plants in segment	-

	B.P.T.	B.A.T.
COST OF POLLUTION ABATEMENT		
Capital costs for segment		
Total capital cost	403,000	1,760,000
Total capital expenditures as % of average annual investment	N.A.	N.A.
Total capital expenditures as % of total capital in place	N.A.	N.A.
Annualized costs for segment		
Total incremental increase including capital charges	182,000	574,000
Total incremental increase excluding capital charges	130,000	272,000
Total incremental increase including capital charges as % of sales	0.1%	0.2%
EXPECTED PRICE INCREASE		
Expected increase due to pollution control	0.1%	0.2%
PLANT CLOSURES		
Total closures anticipated	None	None
% reduction of segment capacity due to closures	-	-

	B.P.T.	B.A.T.
EMPLOYMENT		
Total # of employees affected	None	None
% of total employees in segment	-	-
COMMUNITY EFFECTS	None	None
IMPACT ON INDUSTRY GROWTH	None	None
BALANCE OF TRADE EFFECTS	None	None

INDUSTRY SUMMARY - TEMPERED GLASS

Industry - Tempered Glass
SIC Code - 3211

# Plants in segment	13
% Total plants in industry	24%
# Plants direct discharging	10
% Total plants in segment	80%
# Plants with BPT treatment in place	N.A.
% Total plants in segment	-

	B.P.T.	B.A.T.
COST OF POLLUTION ABATEMENT		
Capital costs for segment		
Total capital cost	560,000	1,030,000
Total capital expenditures as % of average annual investment	N.A.	N.A.
Total capital expenditures as % of total capital in place	N.A.	N.A.
Annualized costs for segment		
Total incremental increase including capital charges	169,000	286,000
Total incremental increase excluding capital charges	95,000	154,000
Total incremental increase including capital charges as % of sales	0.1%	0.2%
EXPECTED PRICE INCREASE		
Expected increase due to pollution control	0.1%	0.2%
PLANT CLOSURES		
Total closures anticipated	None	None
% reduction of segment capacity due to closures	-	-

	B.P.T.	B.A.T.
EMPLOYMENT		
Total # of employees affected	None	None
% of total employees in segment	-	-
COMMUNITY EFFECTS	None	None
IMPACT ON INDUSTRY GROWTH	None	None
BALANCE OF TRADE EFFECTS	None	None

I. INDUSTRY SEGMENTS

A. Introduction

This study is intended to supply the Environmental Protection Agency with an analytical framework for determining the economic impact of water pollution control requirements and proposed water effluent standards upon the flat glass industry. For purposes of the study and to be consistent with studies on the proposed effluent standard and related cost, the industry was segmented into appropriate sectors. Within the scope of this study we intend to cover the following sectors of primary glass manufacturing.

- Sheet Glass
- Plate Glass
- Float Glass

The principal distinction between the sectors is technological, i.e., the manufacturing processes are quite distinct. Markets and applications however do overlap for each segment.

The remaining sector of primary glass manufacturing, rolled and polished glass, was excluded on the basis that it represented a relatively minor fraction of the total glass industry. Due to budget limitations those principal sectors of the flat glass industry related to fabrication - laminated and tempered automotive glass - were not to be included. It became evident at the completion of Phase I of this study that on the basis of preliminary data developed by the contractor carrying out a study of the proposed water effluent guidelines and the related cost to meet these proposed guidelines, that relatively minor water effluent problems existed in the primary flat glass segment of sheet and float glass manufacturing. However, the flat glass automotive fabricating industry sector of lamination and tempering were of somewhat greater concern due to the composition of effluent water streams.

It was agreed at the Phase I review meeting to change the direction of the study within the time and budget remaining to focus on the economic impact of the proposed water effluent guidelines on the flat glass automotive

fabricating sector of lamination and tempering. Obviously within these constraints of time and effort an in-depth analysis was not possible but based on the available information an attempt was made to analyze the economic impact on these segments.

B. Flat Glass Products and Applications

1. Sheet Glass

Sheet glass is a transparent flat glass with a smooth fire-polished surface made by machine drawing in one of a number of semi-proprietary processes. Although sheet glass may be either clear or colored, U.S. consumption is invariably clear. Sheet glass can either be "thin," weighing between 4 ounces and 16 ounces per square foot; "window," weighing between 16 ounces and 28 ounces; or "heavy," weighing over 28 ounces per square foot.

2. Plate Glass

Plate glass is a rolled glass that has been ground and polished to make the glass transparent and to produce parallel surfaces that are virtually distortion-free.

3. Float Glass

Float glass is of a similar quality to plate but is manufactured by floating a layer of molten glass on molten tin in a continuous horizontal ribbon that theoretically could be infinite in its length.

Current technology limits the range of thicknesses in which each type of flat glass can be produced, and these thicknesses thus define the potential applications. Thin sheet glass up to 12 ounces is used for the manufacture of slides, transparencies and picture glass; over 12 ounce thin glass is used in storm windows and for laminating. Window glass is a common glazing material for residential construction and is available single-strength (18-19 ounces) or double (24-26 ounces). Single strength glass is about 3/32" and double strength about 1/8". Heavy sheet glass is the most frequent material used for tempered patio doors and is purchased in thicknesses of 5/32" to 7/32".

Plate and float glass are principally used in automotive applications and in store display windows, curtain walls and high quality mirrors. Plate glass is available in thicknesses of 1/8" to 1-1/2" while float is 1/8" to 1/4"; float glass technology is advancing rapidly in making even thinner sheets that might compete with 3/32" sheet glass in the very near future.

While sheet glass is generally cut for immediate use in residential construction, some of it and the majority of plate and float glass is further processed or fabricated for automotive or building safety applications. This processing is either a tempering or a laminating process. Tempered glass is a type of safety glass that is used principally for glazing the side and rear windows of motor vehicles and is used increasingly in residential patio doors, shower enclosures and large fixed glass panels. Over the past two years, a number of states have enacted legislation to make tempered glass a mandatory product in residential patio doors; when broken, tempered glass crumbles harmlessly instead of shattering. Laminated glass is formed by softening panes of sheet, float or plate glass and then joining them together in a formed shape with an intermediate layer of clear vinyl. Laminated glass is most frequently used in automotive windshields; in these applications the product can be tinted or can have embedded the radio aerial wire.

C. Industry Structure and Characterization

1. Participating Companies

The production of sheet, plate and float glass in the United States is highly concentrated and involves only seven companies. Over 87% of the U.S. output of sheet glass is produced by PPG Industries (PPG), Ford Motor Company, Libbey-Owens-Ford (LOF), and ASG Industries (ASG).

The U.S. producers of float glass are PPG, LOF, ASG, Ford Motor Company, Guardian Industries and C-E Glass (a subsidiary of Combustion Engineering); however, PPG, LOF and ASG account for all of the plate glass manufacturing.

In summary, three firms largely dominate U.S. production of plate glass. PPG and LOF are large, multiproduct firms producing a wide range of flat glass

products, including rolled and tempered as well as other industrial products. The two companies also participate in the foreign production of flat glass through arrangements ranging from process licensing agreements and joint ownership of foreign facilities. The third major company, Ford, produces float and tempered glass primarily for its own consumption in the manufacture of vehicles, but also for sale to the trade.

Two smaller firms - ASG and Fourco Glass Company - also are fairly significant. ASG produces plate, sheet, float and rolled glass (as well as tempered architectural glass) while Fourco's production is limited to sheet glass. Finally, Guardian, while a substantial processor of laminated and tempered automotive glass, only commenced the production of float glass in 1970; C-E Glass did so only as recently as 1971.

Guardian Industries, Ford, LOF and PPG are manufacturers of raw glass as well as fabricators of laminated and tempered automotive glass. These four companies, plus Chrysler who purchases raw glass and fabricates it for its own use in the manufacture of automobiles, probably account for over 80% of automotive glass manufactured in the United States today; the remainder is produced by three small independent companies - Shatterproof Glass Corporation; Safelite Industries; and Safetee. Shatterproof produces both laminated and tempered glass, while the other two companies are only laminators. All three companies purchase raw glass from the major producers for further processing.

LOF is the largest automotive glass fabricator, serving General Motors' needs together with PPG. Shatterproof, Guardian and other small companies mainly supply the replacement market.

2. Product Distribution

The distribution of flat glass in the United States utilizes a variety of distribution channels. It is significant to note, however, that while approximately two-thirds of primary plate and float glass produced in the United States is initially destined for intracompany transfers for further fabrication or processing (mainly for automotive uses), about 85-90% of sheet glass is sold directly to customers through various distribution channels without intracompany processing.

Direct sales from the factory to independent glass distributors, fabricators, processors (such as for automotive applications), and glazing contractors are the most frequently used channel. These prequalified buyers have the advantage over other potential purchasers of flat glass who must order their glass, even in carload lots, at higher prices from the distributors. The major glass producer, PPG, distributes a significant part of its output through captive warehouse and service centers in addition to selling to recognized factory buyers. These outlets serve buyers at all distribution levels and are thus in direct competition with PPG's normal direct factory customers.

Most of these factory buyers are also importers of flat and tempered glass. They place their orders through U.S. sales agents representing the foreign manufacturers or they purchase it from the agents who might have imported glass for their own account. Importers may thus resell the landed product or use it themselves in glazing for manufacturing products that use glass.

Tempered and laminated automotive glass for original equipment, accounting for a major share of the fabricated glass market, is sold directly to motor vehicle manufacturers at negotiated prices. Some automotive replacement glass is distributed by some of the major motor vehicle manufacturers through their new-car dealer franchises. Replacement glass might also be marketed from the producer to the independent glass distributor, hence to the auto glass jobber and then to the auto repair shop.

3. Flat Glass Production Manufacturing

All flat glass production is a continuous process, that is, once production is started it continues around the clock until interrupted by breakdown or shutdown. In this respect flat glass manufacture differs from any other glass forming processes.

Basically the raw material for all three production processes, sheet, plate and float are the same. Minor changes in batch compositions may be made to introduce color and same changes in working conditions of the glass; however,

the major ingredients of silica sand, limestone, soda ash and cullet (recycled plant scrap) remain relatively constant. Raw material storage and batch preparation and feeding to the furnace do not differ significantly in any of the three sectors or from plant to plant within each sector.

Although glass tanks (furnaces) differ in size and detail construction, the basic function is essentially the same in all flat glass manufacturing. The tank provides a high temperature environment in which the raw materials decompose and react to form an inorganic melt of Na_2O-CaO-SiO_2. The residence time in the tank allows for homogenization and removal of bubbles and seeds and results in a high quality glass of the correct viscosity to be delivered to the working section of the tank. The uniqueness of the three flat glass processes begins at the forming end of the tank.

a. Sheet Glass

- Manufacturing Process

There are basically two processes for drawing sheet glass from the working compartment, vertical drawing or horizontal drawing. In the Fourcault and the Pittsburg Process, the glass sheet is drawn vertically through a system of pairs of asbestos covered rollers. Vertical drawn machines may be from 16-30 feet tall. In the Colburn process the glass is drawn upward from the forehearth for a distance of 2 - 2-1/2 ft and then directed into a horizontal position by a guide roll and passed through an annealing lehr (~180 ft). In all three processes the glass is automatically cut in specified sizes, inspected and packaged. Yields vary between 60-75% as a result of edge loss, cutting, breakage and off quality sheet. Characteristics of the sheet glass processes are given in Table 1.

Sheet glass product quality is subject to stria, cords and distortions due to the variations in control of the sheet thickness as it is being formed. Thus, sheet glass quality is considerably below that of plate or float glass but is adequate for residential construction, the primary application.

TABLE 1

APPROXIMATE OPERATING PARAMETERS OF SHEET GLASS PROCESS

Process	Average No. Machines/ Tank	Max. Width	Speed Range* ft/hr	Yield %	Average Time Between Shutdowns
Fourcault	4-6	108"	225-300	65-75	200-250 hrs
Colburn	1-2	144"	320-400		
Pittsburg	4-6	120"	280-400		250-500 hrs

* For single strength window glass (3/32")
Speed is not linear with thickness

- Water Streams

The waste water streams in a sheet glass operation, excluding sanitary sewerage, are all noncontact water. The principal use of water is for cooling around the tank, the forehearth, and at the forming position where water is used to extract heat from the newly formed sheet and to cool the rolls. In addition there is compressor cooling and boiling water. The effluent streams then are the blowdown from the recirculated cooling water, boiler and from water softener regeneration.

In integrated sheet glass facilities that have tempering capabilities for finishing in-plant or intraplant transfer, additional waste water streams exist. These streams are principally contact cooling water in edge grinding, hole drilling and cutting. The effluent stream contains oil, coolant and glass. The flow rates appear to vary considerably from plant to plant, depending on quality of the effluent and might vary from 1-2 gal/day/sq ft of production.

- Plants and Locations

Eleven sheet glass plants have been identified in the United States. The parent company and plant locations are given in Table 2. One-third are located in West Virginia and the remainder in the Midwest, Oklahoma, and California. Although relatively few sheet glass plants have been built in the last 20 years, the technology has not changed a great deal and equipment is reasonably

TABLE 2

FLAT GLASS PLANTS

Company	Type of Plant		
	Sheet	Plate	Float
ASG	Jeanette, Pa. Okmulgee, Okla.	Kingsport,Tenn.	Greenland,Tenn.
Combustion Engrg.			*Floreffe, Pa. Almonesson, N.J.
Ford			Dearborn, Mich. *Nashville, Tenn. Tulsa, Okla.
Fourco	Clarksburg,W.Va.(2) Ft. Smith, Ark.		
Guardian			Carleton, Mich.
LOF	Charleston,W.Va.	Rossford, Ohio	Toledo, Ohio Ottawa, Ill. Lathrop, Calif. **Rossford, Ohio Laurinberg,N.C.
PPG	Henryetta, Okla. Mt. Vernon,Ohio Clarksburg, W.Va. Mt. Zion, Ill. Fresno, Calif.	Cumberland,Md.	Cumberland, Md. Meadville, Pa. Crystal City, Mo. *Carlisle, Pa. Wichita Falls, Tex.

* Under construction

** Planned 1974

modernized. Plant capacities vary from 100 to 680 tons/day output and employ between 150 to 900 production workers. Production per manhour has risen to ~80-85 sq ft/manhour through improved efficiency. New investment in sheet glass facilities over the past seven years has been modest at a total of ~35MM$. (Table 3)

- Employees

The sheet glass industry employs less than 5000 production and related workers, plus an additional 20% other employees. The number of employees has dropped 30% over the past five years. By and large the decrease in employment has been a result of plant closings, although some reduction is due to product efficiency. Reduction in capacity of U.S. sheet manufacturers is in part attributed to lower profitability, competition from float glass products and pressures from imports.

b. Plate Glass

- Manufacturing Process

In the manufacture of sheet glass certain defects are always present. Small variations in thickness are unavoidable and cause distortion. High quality image transmission for undistorted vision requires that the two surfaces of the glass be flat and parallel and this condition can be obtained by grinding and polishing.

Plate glass is produced by a continuous tank rolling process. The molten glass from the tank forehearth flows over a weir or through a refractory slot to define the initial shape. The still viscous glass is then passed between two water cooled rolls to give it final thickness and width. The glass ribbon is stretched slightly to improve dimensional control and then passed into a continuous lehr for annealing. Production speed is controlled by glass level and roll setting and speeds of up to 1250 ft/hr are obtained with maximum widths of 132 inches. Tank outputs are of the order of 250-400 ton/day.

After annealing and cooling, the continuous ribbon is cut to standard size and then ground and polished on one side at a time. Alternatively the twin

TABLE 3

NEW INVESTMENT BY U.S. FLAT GLASS PRODUCERS

January 1964 - June 1971

(000 $)

	Flat Glass		
	Sheet	Plate	Float
Modification of Existing Facilities	15,892	11,714	45,272
New Facilities	19,272	929	171,292
Total	35,164	12,643	216,564

Source: U.S.Tariff Commission Report, No. TEA-1-23, January 1972

grinding process allows for grinding and polishing both sides of the glass simultaneously without interrupting the continuous flow by cutting. In the latter process the glass is supported from below by the grinding and polishing machine. Since the process is a continuous one the speed at the sheet forming end of the line dictates the speed of the finishing operation. Cutting and packaging is similar to other flat glass processes.

- Water Streams

In addition to the normal requirements for noncontact cooling water and discharge from water pretreatment systems (i.e., water softening and ion exchange), the plate glass process uses significant amounts of water in the grinding and polishing stages. Water usage varies from 1.5 to 4 MM gal/day depending on the specific plant.

In plate glass manufacture, the glass is ground flat with silica and polished with iron oxide rouge and/or cerium oxide. This process produces a high level of suspended solids with a low level of dissolved solids and a very low level of BOD in the plant effluent.

The production of plate glass is the most expensive flat glass manufacturing process. Producers of plate glass have been switching over to float glass at a very rapid rate and it is quite possible that in several years there will be at most one major manufacturer of plate glass.

- Plants and Locations

Three plate glass manufacturers have been identified as presently operating in the United States. The locations of plate glass plants are listed in Table 2. Since 1964, 12 plate glass lines have been closed as the market has been consumed by the more effluently produced float glass. Only one of the present plate glass facilities has been built in the past 15 years. The ASG plant at Kingsport, Tennessee was brought on stream in 1960. Plant capacity ranges from 270-380 ton/day with one tank and line per plant. The investment in plate glass facilities over the period 1964-1971 is believed to be about $15.5MM with less than 8% of that investment in new facilities.

The rapid replacement of plate glass capacity with float is expected to continue simply because of process economics. In 1970 the product per manhour in plate glass manufacture was ∿33 sq ft/manhour compared with ∿112 sq ft/manhour in float glass. Plate glass demand was probably about 70 MM sq ft in 1972 -- less than 4% of the total flat glass consumption.

- Employees

The number of employees in the plate glass industry has been reduced drastically over the past five years. From 1967, when the number of production workers was 5560, to 1972 the employees in this industry have been reduced to 1000-1200 workers. Significant numbers of these people have been absorbed by the new float glass facilities however. It is expected that further reductions in the production employees will occur over the next 3-5 years as essentially the remainder of the plate glass facilities are replaced by float capacity.

c. Float Glass

- Manufacturing Process

The float glass process which was developed in the United Kingdom represents the most significant technical development in the flat glass industry in this century. This process makes it possible to produce a continuous ribbon of glass having perfectly flat and parallel surfaces without grinding and polishing. Float glass products have the high surface finish of sheet glass and the flatness and freedom from distortion of high optical quality plate glass.

Tanks for melting and refining of glass for float glass lines tend to be larger than those for sheet glass. Typical tanks have a pull capacity of ∿400-500 ton/day producing 50-150 MM sq ft of product. The process is a continuous in-line operation and one tank serves one line. Production speeds are high and depending upon thickness may reach 1500 ft/hr or greater.

The key element in the process is the fact that the molten glass is drawn from the forehearth on to a molten tin bath and due to the density differences the

molten glass floats and is supported on the tin bath. Surface tension forces result in a natural thickness of the floating glass of 1/4". The top face of the floating sheet is fire polished and the lower surface defined by the tin bath.

The continuous ribbon of glass, after cooling sufficiently to prevent distortions, is drawn from the tin bath on to an annealing lehr to remove strain due to any thermal induced stresses. Cutting and packaging are similar to other flat glass products.

The economics are extremely attractive in that the speeds are high, labor content low and the expensive grinding and polishing is eliminated.

- Water Streams

In float glass facilities the major water use is for noncontact, recirculated cooling water at the tanks and tin bath, boiler feed water and compressor cooling. In addition, some facilities require wash water to remove surface contamination prior to further processing or packaging. The effluent flow varies somewhat from plant to plant and limited data indicates that quantities are of the order of 20-35 gal/ton of glass product. In those cases the glass is washed with detergent, city water, and deionized water. Washing with detergent is gradually being discontinued, so the process wastewater effluent generally contains primarily sodium sulfate (from SO_2 treatment of the glass) at a concentration of about 400 ppm.

- Plants and Locations

In 1972 there were 11 float glass plants in operation in the United States. Since that time the ASG plant in Greenland, Tenn. has come on stream and three additional plants are under construction or are planned for construction this year. By the end of 1973-early 1974, 15 float plants, representing 21 float glass lines will be in production having a total capacity of 1700 MM sq ft of glass. This represents a ∿700% increase in float capacity since 1967. The location of specific plants are listed in Table 2.

Obviously all plants are relatively new and represent substantial investment on the part of the glass producers. The Tariff Commission Report states that 216 MM$ have been invested in new plants and modifications of float glass facilities from 1964 to 1971.

- Employees

The number of production and related employees in the float glass industry segment has risen to nearly 400% since 1967 when the industry employed 1500 workers. By the end of 1973 the production employment should reach 7300. A portion of this growth has obviously come at the expense of employment in plate glass facilities. Commensurate with the increase in employment is the output per manhour which has risen from an average of 87 sq ft/manhour in 1967 to ~120 sq ft/manhour. That figure varies substantially since new plants have been constantly coming on stream; however, it is expected that the efficiency will continue to increase as experience is gained.

4. Flat Glass Fabrication

a. Laminated Glass

- Manufacturing Process

Automotive windshield requirements demand not only resistance to forces of impact but the elimination, as far as possible, of hazards of splintering if fracture occurs. Laminated glass is constructed of two glass plates normally 1/8" thick bonded with an interlayer of 0.015" thick polyvinyl butylate.

The in-line fabrication process begins with template cutting of windshield shapes from large sheets of float glass. Edges are seamed to facilitate handling. Precut and precleaned shapes are bent into windshield shapes by heating sagging in a specifically designed jig or frame. Two mated pieces of glass separated by a parting compound are mounted in the jig and passed through a lehr at the softening temperature of the glass.

Prior to laminating the glass is washed free of dirt and parting compound, interlayered with a sheet of polyvinyl butylate and prepressed between rollers

to remove entrapped air. The final bonding is accomplished in oil or air autoclaves. Oil autoclaves are generally used and pressing is done under a pressure of 28-85 lb/in.^{2} at ∿212°F. Residual oil from the lamination step is removed by draining followed by a series of washing and rinsing cycles. If seaming is done after autoclaving a final wash is used. Fabricated windshields are then packed and shipped.

- Waste Water Streams

Contact water streams in the lamination glass fabrication are primarily wash water. In wet seaming small amounts of water are used to flush away glass particles produced by the grinding process. Initial washing is used to remove oil, grease and dirt prior to sagging. Both once through and recycle type washers are used.

Prelamination washes include washing of the vinyl sheeting and removal of dirt from the glass surface. Three stage washers are used and include detergent wash, city water rinse and ionized water rinse. Water is recycled through the stages and discharged.

The postlamination wash involves removal of residual oil from the autoclaves. Older methods use a first stage detergent wash followed by two or three rinses. More recently some plants include an initial hot water rinse prior to the detergent rinse thus reducing the amount of detergent required. Small amounts of waste water are generated from the separation of oil and water from the autoclaves. Typical flow rates from lamination facilities are of the order of 4300 gal/1000 sq ft of product.

- Plants and Locations

We have identified twelve facilities that participated in the automotive lamination fabrication (Table 4). Approximately 50% of the plants are located in the Midwest, principally Ohio and Michigan. In most cases windshield lamination facilities are integrated with automotive tempering facilities although some large producers segment their operations. The total U.S. capacity for windshield lamination is given as 75,000 sq M/day (810,000 sq ft/day)

TABLE 4

LOCATION OF AUTOMOTIVE FABRICATION FLAT GLASS PLANTS
IN THE UNITED STATES

Company	Type of Plant	
	Laminating	Tempering
Chrysler	Detroit, Mich.	Detroit, Mich.
Ford	Dearborn, Mich.	Nashville, Tenn.
Guardian	Detroit, Mich.	Millburg, Ohio
LOF	Toledo, Ohio	Toledo, Ohio
	Ottawa, Ill.	Ottawa, Ill.
	Lathrop, Calif.	Lathrop, Calif.
		Rossford, Ohio
PPG	Creighton, Pa.	Crestline, Ohio
	Greenburg, Pa.	Tipton, Pa.
		Carlisle, Pa.
Safelite	Wichita, Kan.	
	Enfield, N.C.	
Safetee	Philadelphia, Pa.	
Shatterproof	Detroit, Mich.	Detroit, Mich.

and the average plant size is 6,900 sq M/day (74,000 sq ft/day) according to the effluent guideline development document for the EPA. This work also estimated that 30% of these facilities discharged to municipal systems.

b. Tempered Glass

- Manufacturing Process

Tempered glass is a type of safety glass made by processing flat glass to increase its mechanical strength. Due to the nature of the process, tempered glass when fractured will break into small cubes instead of long sharp slivers thus reducing the probability of serious injury to vehicle passengers and operators. Tempered glass is required in all side and back lites of U.S. automobiles but has been replaced as a windshield structure for some time.

Virtually all tempered and automotive glass is produced by thermal processing of precut flat glass to raise the residual stress of the glass in such a way as to increase its strength. In this process the temperature of the glass is raised near the softening point, the glass removed from the heating furnace and the surface chilled quickly. By and large forced air cooling is used in the automotive tempering operation. The surface layer quickly becomes rigid while the interior is still fluid and expanded. As the temperature gradient through the glass approaches equilibrium the stresses in the surface become highly compressive while the interior is placed under a tensile stress. Therefore, the residual surface compressive stress must be overcome by an applied tension stress before the glass can be fractured. Once the tensile strength of the glass is exceeded and a crack initiated it will propagate and release the high internal stress causing the material to fracture into very small fragments.

Tempered glass cannot be cut or ground after the tempering process. Therefore all cutting, drilling and seaming are done prior to the thermal processing. For curved side and back lites, bending is carried out in the laminating process just prior to the quenching of the surface.

- Waste Water Streams

The principal waste water streams in automotive tempering of glass are in the pretempering operations such as seaming and drilling, and the washing prior to tempering.

In the pretempering operations, small amounts of water are used in the seaming operation to hold down dust. Edge grinding is carried out on all exposed edges of side lites. An oil-water emulsion is used to flush away glass particles. All of this coolant is recycled after removing scum. Holes for window handles and brackets are drilled prior to tempering and coolant water is used to flush away the glass from the drilling operation.

The primary source of waste water is the wash just prior to the tempering process. The glass must be washed free of all dirt, glass particles and oil from the cutting, seaming and drilling operations. Both once through and recyling washers are used and two or more steps for each recycle. No detergents are used in this washing process.

Although air quenching is normally used some operations utilize a water spray. Little if any contaminants are picked up in water spray quenching operations.

The study carried out by the effluent guideline contractor indicates there is a considerable range of process waste water flow depending upon the amount of recycling carried out. A typical plant flow is of the order of 49ℓ/gm (1200 gal/1000 sq ft). Twenty percent of the plants surveyed were discharging to municipal systems.

- Plants and Locations

It is estimated that there are 13 facilities engaged in tempering and automotive back and side lites. There are a large number of additional tempering operations, mostly smaller facilities, that do not participate in the automotive market. By and large the principal tempering operations are located in the Midwest in close proximity to the automobile manufacturers. Tempering facilities are in many cases integrated with windshield laminators and sometimes continguous to primary glass manufacturing plants. The effluent

guideline development document gives the total U.S. capacity as 95,500 sq M/day (1,050,000 sq ft/day) and the plant sizes ranging from 1,396-24,700 sq M/day (15,000-266,000 sq ft/day).

- Number of Employees

The total number of employees in all glass tempering operations increased from 17,779 to 18,750 in the period 1967 to 1968; however there was a decline to 16,139 in 1970 according to the Tariff Commission Report. Over that same period the output per manhour increased from 29.7 sq ft/hr in 1967 to 32 sq ft/hr in 1970.

5. Shipments and Consumption of Flat Glass

Domestic shipments of sheet glass have changed only slightly over the past five years (Table 5), but have lost market penetration. From a level of 1.1 billion square feet in 1968, the shipments of sheet glass have generally moved with the level of residential construction and reached 1.2 billion square feet in 1972, dropping slightly in 1973. By value, shipments totalled $139 million in 1968 and reached $157 million in 1972.

Plate, float, rolled, and wire glass shipments increased from 656 million square feet in 1968 to 1405 million square feet in 1973. (Less than 5% of this total is represented by rolled or wire glass.) The value of shipments also increased substantially from $248 million in 1968 to $433 million in 1973. No breakdowns are available for the shipments of plate as opposed to float glass but the proportion of float has increased from zero in 1964, when it was first introduced to the United States, to a level believed to be about 95% of plate-float production.

Table 6 shows the flat glass shipments by U.S. producers in detail for 1973. While sheet glass represented about 45% of total flat glass on a surface area basis, it was only 28% of total tonnage and 26% of value of shipments. Window glass, in single and double strengths, totalled 89% of sheet glass shipments, this proportion increasing gradually over the years as heavy sheet glass is replaced by float. Thin glass has similarly declined and is now only 2% of total sheet glass.

TABLE 5

SHIPMENTS OF FLAT GLASS, 1968 - 1973

	Sheet Glass Including Colored, Total		Plate, Float, and Rolled and Wire Glass	
	1000 sq ft	Value $1000	1000 sq ft	Value $1000
1968	1,095,800	139,391	656,004	248,078
1969	1,160,950	150,123	705,244	266,747
1970	1,069,700	131,551	698,394	253,239
1971	1,188,750	150,344	943,064	314,330
1972	1,196,700	157,222	1,191,830	393,263
1973	1,126,900	152,242	1,404,567	433,048

Source: U.S. Department of Commerce/Bureau of the Census, Current Industrial Reports (MQ-32A)

TABLE 6

FLAT GLASS SHIPMENTS BY U.S. PRODUCERS, 1973

	Quantity			
	MM sq ft	%	MM lbs	%
Flat Glass, Total	2501.1	100.0	4762.3	100.0
Sheet Glass, Total	1125.0	45.0	1339.4	28.1
Single Strength, Uncolored	699.0	27.9	831.8	17.5
Double Strength, Uncolored	297.0	11.9	353.4	7.4
Heavy Sheet, Uncolored	110.1	4.4	131.0	2.8
Thin and Tinted or Colored	19.5	0.8	23.2	0.5
Plate, Float, & Rolled and Wire Glass	1376.1	55.0	3422.9	71.8
Plate & Float, not over 1/8"	541.1	21.6	882.0	18.5
Plate & Float, over 1/8", not over 1/4"	749.5	30.0	2248.5	47.2
Plate & Float, over 1/4" and Rolled and Wire	85.5	3.4	292.4	6.1

	Value (MM$)	%
Flat Glass, Total	576.0	100.0
Sheet Glass, Total	152.3	26.4
Single Strength, Uncolored	92.3	16.0
Double Strength, Uncolored	41.0	7.1
Heavy Sheet, Uncolored	14.3	2.5
Thin and Tinted or Colored	4.7	0.8
Plate, Float, & Rolled and Wire Glass	423.7	73.6
Plate & Float, not over 1/8"	140.3	24.4
Plate & Float, over 1/8", not over 1/4"	245.9	42.7
Plate & Float, over 1/4" and Rolled and Wire	37.4	6.5

	Unit Value (¢/lb)
Flat Glass, Total	12.1
Sheet Glass, Total	11.4
Single Strength, Uncolored	11.1
Double Strength, Uncolored	11.6
Heavy Sheet, Uncolored	11.0
Thin and Tinted or Colored	20.3
Plate, Float, & Rolled and Wire Glass	12.4
Plate & Float, not over 1/8"	16.0
Plate & Float, over 1/8", not over 1/4"	10.9
Plate & Float, over 1/4" and Rolled & Wire	12.8

Source: U.S. Department of Commerce/Bureau of the Census
Current Industrial Reports (Series MQ-32A)

The majority of plate and float glass shipments are between 1/8 inch and 1/4 inch in thickness -- 55% on a surface area basis and 66% by weight. These proportions have remained fairly constant over the past five years and are not expected to change significantly in the near future.

Imports of sheet glass were significant during the 1960's and reached a level in 1968 that caused sufficient alarm in the industry for it to seek some form of action by the U.S.Tariff Commission. In that year, sheet glass imports totalled 629 MM pounds, accounting for 32% of U.S. consumption. Imports declined in 1969 and 1970 but then increased in 1971 and 1972 because of the strong residential construction market in the United States, reaching about the same level of 1968. On a square foot basis, sheet glass imports accounted for 40.5% of the U.S. consumption in 1972.

U.S. imports of plate and float glass also increased gradually in the late 1960's and in 1972 reached a level of 93 MM square feet. This total amounted to 6.4% of apparent U.S. consumption of plate and float glass, below the ratio of 8.2% reached in 1968. Exports of sheet, plate or float glass have not been significant. However, exports of plate and float have increased gradually and totalled 66 MM square feet in 1972 -- 7 MM square feet of plate glass and 59 MM square feet of float.

In Table 7 we show the apparent consumption of flat glass for 1972. This table shows that consumption totalled 2.9 billion square feet in that year and that imports represented an average of 21% of consumption.

The overall demand for automotive glass is dictated largely by the level of production of passenger cars and other motor vehicles. Laminated glass, frequently curved, is the only type of glass used in the windshields of vehicles and solid tempered glass in the side and back lites. As Table 8 shows, the U.S. consumption of automotive glass in 1972 totalled 830 million square feet, or 28% of raw glass consumed.

Windshields are manufactured by laminating two thicknesses of raw glass precut to the desired shape; each piece measures from 10 to 14 sq ft in surface

TABLE 7

APPARENT CONSUMPTION OF FLAT GLASS, 1972

(Millions of sq ft)

	Sheet	Plate and Float	Total
Domestic Shipments	1197	1191	2388
Imports	524	93	617
Exports	2	66	68
Apparent Consumption	1719	1218	2937
Imports as % of Consumption	30.5	6.4	21.0

Source: Contractor estimates, based on Department of Commerce data

TABLE 8

U.S. CONSUMPTION OF AUTOMOTIVE GLASS, 1972

	Float		Sheet and Other		Total	
	%*	MMSF	%*	MMSF	%*	MMSF
OEM	55	630	2	35	-	665
Replacement	10	115	3	50	-	165
	65	745**	5	85	28	830

* of total raw glass consumed

** Float glass represents 90% of flat glass consumed in automotive applications

Source: Contractor estimates

area, averaging 11 sq ft. Rear and side windows of tempered glass are 7/32-inch single thickness and measure 8 sq ft and 10 to 12 sq ft, repectively although these surface areas can vary widely according to model and year.

Original equipment applications for automotive glass totalled 665 million sq ft in 1972, with replacement units making up the remainder. Original equipment applications are a major user of float glass, taking 55% of total U.S. consumption, with a further 115 million sq ft of float glass going to the replacement market. Approximately 5% of sheet and other types of raw glass are consumed in automotive applications, totalling 85 million sq ft in 1972. On aggregate, automotive applications take 28% of U.S. raw glass consumption.

In Table 9 we showed the applications of automotive glass in 1972. We estimate that approximately 530 million sq ft of laminated glass (single thickness) is consumed with about 30% of the laminated units going to the replacement market and the remainder going to original equipment. Of the 300 million sq ft of tempered glass consumed, only 5% is taken for replacement applications.

Foreign trade in automotive glass, as shown in Table 10, totalled 64.5 million dollars in imports and 31.7 million dollars in exports in 1973; imports declined and exports increased over 1972. It is estimated that approximately half of the imports enter from Canada for use as original equipment in the manufacture of automobiles and are duty-free under the Automotive Products Trade Act of 1965. These entries include float glass shipped to Canada by U.S. producers for processing by their Canadian subsidiaries and then returning to the automobile plants in the United States. A large proportion of exports are also finished processed units going to the Canadian assembly and replacement market. Included in the data for tempered glass, both imported and exported, is a certain proportion of architectural glass used for patio doors and other safety applications, but this is believed to be small.

Real growth in value of flat glass in the United States in 1972-1980 is expected to be at the rate of about 3% for building construction applications,

TABLE 9

APPLICATIONS OF AUTOMOTIVE GLASS, 1972

(Million Square Feet)

	Laminated	Tempered	Total
OEM	380	285	665
Replacement	150	15	165
	530	300	830

Source: Contractor estimates

TABLE 10

FOREIGN TRADE IN AUTOMOTIVE GLASS, 1973

	Imports		Exports	
	MMSF	$MM	MMSF	$MM
Tempered	37.8	34.8	21.5	20.1
Laminated	-	29.7	10.2	19.3
	-	64.5	31.7	39.4

Average Value ($/SF)

	Imports	Exports
Tempered	0.92	0.93
Laminated	-	1.89

Source: Department of Commerce Data

below the anticipated growth rate for the Gross National Product, and at about 2.5% annually for automotive applications. It is estimated that approximately 70% of sheet glass consumption is in windows and other building-related applications and that 30% goes to miscellaneous uses, including some laminating and tempering for automotive applications. Sixty-five percent of plate and float consumption finds use in the automotive industry, with the remaining 35% in building construction, furniture and miscellaneous other uses. Thus, the projected demand for sheet glass will probably average about 2.5% annually to the end of the decade and that for plate and float glass about the same. However, the growth rate of float glass could be considerably faster than 2.5%/year as plate glass facilities are shutdown and as float glass becomes technologically capable of replacing sheet glass in window applications.

Other potential product trends which could affect demand include a greater proportion of tinted or colored float glass for reflective architectural uses and the increased demand for tempered glass for safety applications in buildings. Also, the current mood of the automobile consumer in favor of small vehicles in order to save fuel and to minimize on parking problems will affect automotive glass demand. Our conversations with automotive glass producers shows a short-term trend to larger pieces for basically the same vehicle, reflecting both higher visibility requirements and the impact of the recessed windshield wiper that requires an additional five to six inches of glass below the hood. However, the long-term domestic trend will undoubtedly be to a smaller average-sized vehicle and thus a reduction in the size of both new and replacement automotive glass.

6. Intra-Industry Trends

Factors completely independent of any impacts of water pollution control appear to be operating within the basic glass manufacturing segments of sheet, plate and float glass. Basically the efficiencies and economics of float glass production are having a considerable effect on the future development of the industry. The future demand for flat glass products will continue to grow at least at a rate of 3.3 - 3.8% per year, a healthy demand situation. The

dollar volume of manufacturer shipments has grown at an average rate comparable to the growth rate of the GNP and it would seem unlikely that this relationship would change substantially over the next five years.

During the recent growth of the industry, it is important to recognize the interrelationship between the three segments of sheet, plate and float glass. Since the introduction of the float glass process, this technology has rapidly replaced the production of plate glass. Throughout these years the bulk of float glass has been sold to markets formerly served by plate glass. As the technology developed where thinner than 1/4" glass could be produced by float, not only construction markets but the important automotive glass markets switched to float glass. To date the replacement of plate by float glass is essentially complete.

The tremendous rapid increase in float capacity in the recent past and new facilities planned in the next two years has raised a question concerning the supply/demand of float glass (Table 11). With the replacement of plate glass with float complete, it is expected that in the future float glass will penetrate the sheet glass market as well. At least one firm has already announced its intention to use an intermediate quality float glass in the double strength window glass market now served by sheet glass. The investment in float glass facilities by the major producers - ten times more than in sheet and plate facilities combined - seems to substantiate the trend.

Thus it would appear that plate glass facilities will continue to be shutdown as new float capacities come on stream. It is unlikely that more than one plate plant will be operating three years from now. The effects on the sheet glass segment will occur at a slower rate and will depend on the rate of market penetration of float into the areas traditionally served by sheet glass.

By and large the future capacity of the plate and sheet facilities in the United States will probably be governed by economic and marketing factors independent of any impact of water pollution control. However, it is conceivable that additional costs associated with meeting guidelines could accelerate plant closings particularly in the plate glass segment.

TABLE 11

FLOAT GLASS: SUPPLY AND DEMAND CAPACITY PROJECTIONS

(Million Square Feet)

	1967	1968	1969	1970	1971E	1972E	1973E	1974E	1975E
U.S. Producers' Shipments of Float Glass	243	409	529	669	1040	1200	1470	1800	2050
Year-end Float Glass Capacity	280		600		1160		1730		2100

Source: F.S.Smithers & Co., Inc., estimates

II. FINANCIAL PROFILES

Table 12 displays the significant financial data for the publicly held U.S. flat and automotive glass producers. Most of these companies are fully integrated, multiproduct and multi-industry participants with significant positions in the U.S. economy. Glass sales naturally represent a greater proportion of the sales of the smaller companies such as Shatterproof, Guardian and ASG, but is still a significant portion of LOF's and PPG's total business. Data is unavailable for either Combustion Engineering's or Ford's glass businesses but glass sales are a small proportion of total business for either. Financial data on private companies (Safetee, Safelite) are also unavailable.

Data on the manufacturing costs and profitability of individual facilities is not available, but the data shown in Table 13, computed from information submitted to the U.S. Tariff Commission by the U.S. producers, does indicate the level of net operating profit before taxes for sheet, plate and float glass.

The relative difference in profitability between sheet, plate, and float glass is dramatically seen in this table. The profitability of sheet glass in the late 1960's was very low and ranged from a breakeven situation in 1970 to a net profit as a percentage of net sales of 5.9% of net sales in 1969. Plate glass only returned a 5% net profit on net sales in 1970, but this was significantly lower than the 15% to 20% experienced in the three preceding years. Float glass has, in general, been improving its profitability over time. In 1967 the net profit as a percentage of net sales was 28.8%; in 1969 it was 37.2%, and then dropped slightly to 33.4% in a poor demand year. In all cases, operating profits are believed to have increased substantially over the 1970 levels for the years 1971 and 1972.

Sheet glass is still a relatively unprofitable business and speculation is strong that existing facilities will be phased out gradually as float capacity comes on stream and as float technology permits the production of thinner glass.

TABLE 12

1973 FINANCIAL DATA - FLAT AND AUTOMOTIVE GLASS MANUFACTURERS

($ Values in Millions)

	Basis for Year End	Net Sales	Net Earnings	Working Capital	Share-holders' Equity	Return on Equity	Glass Net Sales	Glass Earnings Before Taxes	Glass Sales as % of Total Sales
PPG Industries	Dec. 31	1512.6	104.4	393.1	802.6	13.0	665.5	51.2	44.0
Ford Motor Company	Dec. 31	23015.1	906.5	1660.5	6405.1	14.2	N.A.	N.A.	N.A.
Libbey-Owens-Ford	Dec. 31	689.2	62.2	113.2	370.3	16.8	463	48.5	67.2
American Saint-Gobain	Dec. 31	67.3	2.9	24.9	25.5	11.4	N.A.	N.A.	~95.0
Guardian Industries	Dec. 31	87.2	9.2	14.8	32.8	28.0	75.1	8.1	86.1
Combustion Engrg.	Dec. 31	1272.7	43.6	148.8	321.1	13.4	N.A.	N.A.	N.A.
Shatterproof Glass	Oct. 31	45.2	(0.1)	15.3	22.9	(0.4)	45.2	(0.1)	100.0

Source: 1973 Company Annual Reports and Contractor estimates.

TABLE 13

FINANCIAL PROFILE OF OPERATIONS, 1967 - 1970

	1967	1968	1969	1970
		Sheet Glass (¢/lb)		
Net Sales	10.6	10.5	10.2	9.6
Cost of Goods Sold	9.1	8.7	8.5	8.6
Admin. and Selling Expenses	1.2	1.2	1.1	1.0
Net Operating Profit before Taxes	0.3	0.6	0.6	neg.
Net Profit as % of Net Sales	2.8	5.7	5.9	-
		Plate Glass (¢/SF)		
Net Sales	37.8	38.2	38.7	42.1
Cost of Goods Sold	26.8	27.4	29.6	36.1
Admin. and Selling Expenses	3.3	3.0	3.3	3.9
Net Operating Profit before Taxes	7.7	7.8	5.8	2.1
Net Profit as % of Net Sales	20.4	20.4	15.0	5.0
		Float Glass (¢/SF)		
Net Sales	32.9	32.6	33.3	31.7
Cost of Goods Sold	20.9	17.7	17.4	17.5
Admin. and Selling Expenses	2.5	3.2	3.5	3.6
Net Operating Profit before Taxes	9.5	11.7	12.4	10.6
Net Profit as % of Net Sales	28.8	35.8	37.2	33.4

Source: U.S. Tariff Commission Report No. TEA-1-23; January 1972

As most automotive glass producers are integrated concerns or privately held, specific financial data on tempered and laminated glass production is only available from Shatterproof Glass Corporation. This is shown in Table 12. Integrated producers generally transfer raw glass at a computed market value and, as prices for automotive glass are very competitive, processors do not achieve very high levels of profit. In fact, operating losses or a breakeven situation is generally the case with most manufacturers in their process operations. The financial returns of Shatterproof have always been good, reflecting the company's concentration on glass processing, but 1972 profits were less than half the record levels reached in 1971 due to weaker prices, despite a strong market demand.

Capital requirements for new float glass facilities will be considerable. In the period, January 1964 to June 1971, the industry expanded $217 MM in new facilities, $171 MM on modifications to existing ones at 12 locations. Since that time an additional 10 lines have been added or will be added by the end of 1974. These lines range in investment from $20 MM to $25 MM, depending on the rated capacity (usually 400 to 600 tons per day) and whether the line is an addition to an existing one or at a completely new facility.

It is not inconceivable that at least six of the 12 sheet glass plants presently in operation, and the three plate glass plants, will be closed down within five years as a result of their technology and economics. These closedowns will only be accelerated, and not stimulated, by the potential increases in costs brought about by pollution abatement requirements.

III. PRICE EFFECTS

The distribution channels discussed earlier help to define various levels of pricing that exist in the marketplace today. Typically, a direct factory buyer will be able to obtain more competitive prices than a purchaser who has to obtain his stock from independent glass distributors or from the PPG distribution centers. Nonfactory buyers who have been forced to seek competitive prices have thus examined the imported products.

Published price lists for window glass show variations with thickness, size, quality, and packaging of the sheets, and it has been calculated that as many as 270 different prices may theoretically be available for combinations of these different specifications. In practice, about one-half of that number is listed and thus no "typical" product combination exists. List prices are the same for the leading producers and are quoted freight prepaid to continental U.S. destinations. Freight absorbed in this way averages seven or eight percent; freight allowances or rebates are allowed for factory pickup and this is estimated to be done in at least 50% of sheet glass shipments.

List prices are invariably higher than actual prices paid as discounts are almost always obtainable by purchasers. The level of these discounts will vary depending upon the demand conditions existing, but averages have ranged up to 13% in a relatively poor demand year such as 1970 and currently average about 8%. These discounts are also obtainable on a greater proportion of total shipments in poor years -- 27% in 1970 -- but typically this proportion would be less than 20%. These proportions are less for plate and float glass as a substantial fraction of shipments of these products are on a negotiated and contract basis directly to OEM customers. Thus, average discounts below published prices are currently probably no more than five percent for plate and float, and are probably given in less than two percent of total shipments. Apart from these differences, product pricing is structured similarly to sheet glass and varies with product form.

The prices of automotive glass are negotiated and depend on a variety of considerations, including size and shape of the piece, as well as the volume of order. As Ford and Chrysler supply the bulk of their own needs, competition is aggressive for the business of the other automotive manufacturers and these negotiations can be crucial, although the automobile manufacturer is relatively more concerned with timely delivery and consistent quality. Price competition is even more severe in serving the replacement market as a number of functional markups occur before arriving at a retail selling price and price is often the sole criteria on which wholesalers and retailers purchase.

Unit prices of sheet glass averaged 11.0¢/lb in 1972 as compared to 13.1¢ for plate and float and 12.4¢ for all flat glass. The flat glass wholesale price index, as reported by the Bureau of Labor Statistics, has moved as follows over the last five years:

1967	100.0	
1968	104.4	
1969	109.6	+5.0
1970	115.6	+5.5
1971	123.9	+7.2
1972	122.4	-1.2
Dec. 1973	123.6	+1.0

This index conceals the price drops experienced by sheet glass in 1970 as float and plate prices generally held up. The drop in the index in 1972 probably reflects the effects of the price freeze and would be contrary to normal expectations in what was a high demand year. Prices have firmed and recovered somewhat since, and the index stood at 124.6 in February 1974.

Because automotive glass prices are mostly negotiated or heavily discounted, no firm data exists and current net unit values range from $1.50 to $1.90 per sq ft for laminated windshield glass and from $0.50 to $0.75 per sq ft for tempered side and rear windows. Average replacement market prices experienced a sharp drop in 1972 because of added processing capacity in the industry.

The ability of the flat glass industry to pass on increased cost caused by new pollution abatement requirements would depend upon the product being marketed. It is believed that imported sheet glass requires a price advantage of about five percent to be competitive with domestic production; currently the price gap is almost nonexistent because of the strong demand for materials available from any source. Under normal circumstances, therefore, domestic producers could increase the price of sheet glass up to five percent from current levels before losing market share to importers and thus impacting their profitability.

The United States is in a strong competitive position relative to imported float and plate glass products. We believe that U.S. producers would not have their sales significantly impacted by price increases of 5% to 10% relative to foreign competition and would still retain attractive returns on investment, but the latter conclusion is merely speculative on the basis of incomplete data.

Automotive glass for replacement use is totally price inelastic at the retail level as no competitive material exists, but is very competitive at each level from the fabricator to the retailer; OEM prices are relatively less competitive because of the other qualitative factors, discussed earlier, that enter the decision process. The ability of the processing industry to pass on increased costs, therefore, would depend largely on intra-industry competition and import competition. Because of the difficulty in serving the replacement market with its wide variety in sizes and styles of glass and because of the stringent delivery requirements of the original equipment manufacturers, imported automotive glass has never been a serious factor in the U.S. market. (This is true with the exception of duty-free imports entering from Canada under the Automotive Products Trade Act of 1965 and destined for original equipment manufacture.)

IV. IMPACT ANALYSIS

A. Major Segments

In Part I of this report the major segments of the flat glass industry were set forth and the product, technology, plant characteristics and other relevant information on each segment detailed. In this section the economic impact of proposed water pollution control requirements and proposed effluent standards on each of these segments will be analyzed.

The major segments of the flat glass industry included the three segments of primary glass manufacturing and the two segments related to flat glass fabrication -- namely, laminated and tempered automotive glass.

In this study the economic impact of the cost of pollution abatement requirements was analyzed for three levels of treatment.

- Proposed Best Practicable Technology (B.P.T.) currently available - to be met by industrial dischargers by 1977
- Proposed Best Available Technology (B.A.T.) economically achievable - to be met by 1983
- Proposed New Source Performance Standards (N.S.P.S.) - approximately January 1, 1974.

The economic impact on each segment of the industry is examined for the above three levels in terms of price effects, profitability, production curtailment, employment effects and related community effects.

B. Sheet Glass Manufacturing Segment

1. Best Practicable Technology

In the manufacture of sheet glass products, no process waste waters are involved in the process. Therefore, no waste water or waste load should be discharged.

In light of these findings in the study by the guidelines contractor, no additional costs are anticipated in sheet glass manufacturing operations and correspondingly there will be no impact on price, profitability, production curtailment, employment or the community.

2. Best Available Technology

Similarly, the lack of waste water streams and the no discharge requirement do not impose any related cost on the industry and therefore no excessive impact can be expected.

3. New Source Performance Standards

Requirements for water pollution controls for new sources of sheet glass manufacturing are the same as for B.P.T. and B.A.T. and therefore no economic impacts are anticipated.

C. Float Glass

1. Best Practicable Technology

The proposed limits on waste water effluent for float glass manufacturing plants are given in Table 14 for all three levels of control. For B.P.T. the proposed alternative involved the elimination of detergents in the washing process. No costs are associated with meeting B.P.T. and only a change in plant practice of using detergents is involved. Therefore, no economic effect on price, production, profitability, employment, or the community will result.

2. Best Available Technology

The proposed requirement for B.A.T. is diatomaceous earth filtration. In Table 15 the cost to meet this limit is minimal, although the exact cost will depend somewhat on total production of the plant.

In light of the small incremental cost and the healthy condition of this segment of the industry, no economic impact is anticipated.

3. New Source Performance Standards

The proposed limit for new sources of float glass manufacturing is the same as for B.A.T. Considering the substantial investment in new float glass facilities, incremental investments and costs associated with N.S.P.S. limits will not impose any restrictions on future plant construction.

D. Plate Glass

1. Best Practicable Technology

The proposed process waste water limits for plate glass manufacturing facilities are summarized in Table 14 for a typical plant having an annual production of 150,000 metric tons and a waste water flow rate of 45,900ℓ/MT. The costs to meet the proposed level on limitations are given in Table 2 at ∿$33,000/year.

a. Price Effects

On a unit cost basis the incremental annual cost, 0.01 cents/lb compares to a present selling price of approximately 13 cents/lb for plate glass. This small incremental unit cost will have no impact on the price of plate glass.

b. Financial Effects

Since the incremental cost of meeting proposed B.P.T. controls is small and may be passed on, the effect on profitability is nonexistent. Other factors have in the past and will in the future have far greater effects on profitability. Plate glass has not remained as a competitive process for producing flat glass. The replacement by float produced glass is about complete and this factor will remain the overriding one in profitability considerations.

c. Other Effects

At the present time there are only three plants in the United States manufacturing glass by the plate process. We believe that by 1977 when B.P.T. controls are instituted that at most one plant will be operating. Whether that remaining facility continues operation will certainly depend on other factors than any incremental cost associated with water pollution control.

2. Best Available Technology

While the incremental costs associated with meeting proposed B.A.T. guidelines (Table 15) are larger than those imposed by B.P.T. requirements, they are still modest. Our conclusions as to the economic impact of B.A.T. controls are equally valid and the future of this segment of the industry is highly doubtful for other reasons.

3. New Source Performance Standards

No future construction of plate glass facilities is anticipated.

E. Solid Tempered Automotive Glass

1. Best Practicable Technology

The recommended control technology involves coagulation-sedimentation with sludge dewatering by centrifugation. The proposed effluent levels are given in Table 14.

The production data (Table 16) is taken from the effluent guideline development document and an average tempering plant is assumed to have an annual output of 29 million square feet while a typical plant is given as 37.5 million square feet of annual production. In Table 17 we have summarized the required investment and annual operating cost for the associated level of control technology. These data are extracted from Supplement A to the effluent guideline development document. In preparing these economics the contractor considered the age and size of the production facilities as a possible means of subcategorization but concluded that these criteria are not a proper basis for subcategorization.

a. Price Effects

The annual operating cost resulting from the recommended B.P.T. control technology will have little or no effect on selling prices of tempered automotive glass. On a unit basis, these annual operating costs total 0.065 cents per sq ft as compared to a current average selling price of 50 cents per sq ft. We conclude that these costs will be passed on by the automotive glass fabricators.

b. Financial Effects

- Profitability

As all anticipated costs will be able to be passed on in the form of price increases, the recommended control and treatment technology will impose no negative effects on current rates of profitability.

- Availability of Capital

Investment requirements for the typical tempering facility total $81,000 for B.P.T. A comparable figure for the average plant in operation today is $63,000, while the aggregate industry investment requirements is $560,000. We believe the required capital will be available on a plant-by-plant and company-by-company basis and the industry will in no way have to restrict production or additions to capacity because of capital availability.

2. Best Available Technology

The effluent requirements for B.A.T. can be met by the use of filtration (oil absorptive diatomaceous earth) in addition to B.P.T. technology.

The economic cost data to meet B.A.T. requirements for a typical plant are given in Table 17, extracted from Supplement A to the effluent guideline development document.

a. Price Effects

The annual operating cost resulting from the recommended B.A.T. control technology will have little or no effect on the selling price of tempered automotive glass. On a unit basis their annual costs are 0.11 cents per sq ft. This annual incremental cost will be passed on by the automotive glass temperers.

b. Financial Effects

Since the small incremental cost will be passed on there should be no effect on profitability.

Investment requirements for B.A.T. control technology are $149,000 for the typical plant; an average plant will have an additional investment of $115,000, while the aggregate industry investment for B.A.T. is $1.03 million. We believe this required capital will be available on a plant-by-plant and company-by-company basis and that capital availability will not affect present production or future expansion.

3. New Source Performance Standards

Proposed N.S.P.S. control technology for new sources is identical to proposed B.A.T. controls and therefore the associated cost and related impact will be the same as for B.A.T.

F. Laminated Windshield Fabrication

1. Best Practicable Technology

The proposed controls for B.P.T. for windshield fabrication involve a modification of the post lamination washer sequence to provide a continuously recycling hot water rinse, oil removal by centrifugation of the recirculating hot rinse water, recycling of oil back to the process and treatment of other post lamination rinse water by gravity oil separation.

In Table 16 the production data contained in the effluent guideline development document for a laminating facility are shown. An average laminating plant has an annual capacity of 18.5 million square feet as compared to the assumed typical plant of 8 million square feet.

In Table 17 we summarize the required investment and annual operating cost for each level of control technology extracted from Supplement A of the effluent guideline development document. Again, it was concluded by that contractor that plant size and age were not a basis for subcategorization.

a. Price Effects

The unit cost for meeting the proposed B.P.T. control is 0.18 cents per sq ft as compared to current manufacturers' selling price of approximately $1.50

per sq ft for flat laminated glass and approximately $1.80 per sq ft for curved windshields. Thus, we conclude that the cost resulting from the recommended control and treatment technologies will have little or no effect on selling prices. Any incremental cost will be passed on in the form of price increases.

b. Financial Effects

- Profitability

No negative effects on current profitability are anticipated as the small incremental costs will be passed on.

- Availability of Capital

Investment requirements for a typical laminating facility total $32,000 and for the average plant this figure is $75,000. The aggregate for the automotive laminating industry is $0.8 million to meet the proposed B.P.T. controls. We believe that this capital will be available and will not limit current production or future expansion.

2. Best Available Technology

The proposed control technology for B.A.T. includes that imposed by B.P.T. and described above plus oil absorptive diatomaceous earth filtration of the total process waste water discharge and reduction of detergent usage.

The related cost data estimated to meet the B.A.T. control is also given in Table 17 for the typical plant.

a. Price Effects

For proposed B.A.T. control, the unit cost for laminated windshields is 0.41 cents per sq ft. Compared with current prices of $1.50 per sq ft and $1.80 per sq ft for present flat and curved laminated windshields, these incremental costs are small. We conclude that costs will be passed on.

b. Financial Effects

There should be no negative effects on present profitability, since the small incremental cost will be passed on.

The investment requirements for a typical laminating facility will be $115,000 and for an average plant $266,000. The aggregate automotive laminating industry cost will be $2.9 million. We believe these capital requirements are available.

c. Other Effects

Based on the conclusions above, no effects are anticipated on production, employment or the local community from the incremental cost of meeting the proposed B.A.T. requirements.

3. New Source Performance Standards

The proposed control requirements for N.S.P.S. are identical with those proposed for B.A.T. and the conclusions of no impact are equally valid.

TABLE 14

TENTATIVE EFFLUENT REQUIREMENTS FOR FLAT GLASS INDUSTRY FOR B.P.T., B.A.T. AND N.S.P.S. CONTROLS

(Effluent Flow Based on Typical Plant Size)

	FLOAT				PLATE				TEMPERED				LAMINATED			
	B.P.T.	B.A.T.	N.S.P.S.		B.P.T.	B.A.T.	N.S.P.S.		B.P.T.	B.A.T.	N.S.P.S.		B.P.T.	B.A.T.	N.S.P.S.	
Typical Plant Size	360,000 Metric Tons (400,000 tons)				150,000 Metric Tons (165,000 tons)				3.5 x 10^6 Sq.Meters (37.5 x 10^6 Sq.Ft.)				750,000 Sq. Meters (8.0 x 10^6 Sq.Ft.)			
Effluent Constituents			S A M E	D I S C H A R G E			N O D I S C H A R G E	S A M E			S A M E				S A M E	
Flow	138ℓ/MT				45,900ℓ/MT	9,200ℓ/MT			49ℓ/sqM	49ℓ/sqM			175ℓ/sqM	175ℓ/sqM		
Suspended Solids	2g/MT	.70g/MT			1.38Kg/MT	.045Kg/MT			1.22g/sqM	.24ℓ/sqM			4.4g/sqM	.88g/sqM		
Dissolved Solids	14g/MT															
COD																
BOD																
Oil	1.4g/MT	1.4g/MT	B.						.64g/sqM	.49g/sqM	B.		1.76g/sqM	1.76g/sqM	B.	
Phosphorous	.05g/MT	.05g/MT	A.								A.		1.07g/sqM	0.30g/sqM	A.	
pH	Within Range 6-9		T.		Within Range 6-9				Within Range 6-9		T.		Within Range 6-9		T.	

Source: Effluent Guideline Development Document

TABLE 15

SUMMARY OF INVESTMENT AND ANNUAL OPERATING COSTS

($000's)

Float Glass (Typical Plant 400,000 Tons)	B.P.T.	B.A.T.
Investment	N	134
Operating Cost	O	
Capital		11
Depreciation	C	6.7
Operating & Maintenance	O	28.4
Energy & Power	S	12.5
Total Annual Cost	T	58.6
Equivalent Unit Cost (¢/lb)		neg.

Plate Glass (Typical Plant 165,000 Tons)	B.P.T.	B.A.T.
Investment	57	656
Operating Cost		
Capital	4.6	52.5
Depreciation	2.9	32.8
Operating & Maintenance	22.7	49.7
Energy & Power	2.6	3.5
Total Annual Cost	32.8	138.3
Equivalent Unit Cost (¢/lb)	0.01	0.04

Source: Effluent Guideline Development Document

TABLE 16

PRODUCTION DATA* - AUTOMOTIVE GLASS PLANTS
(MM Square Feet of Surface Area)

	Laminating	Tempering
Number of Plants	11	9
Total Industry Capacity	200	260
Average Plant Size	18.5	29.0
Range	1.8 to 42.5	3.8 to 66.5

*Assuming 250 days/year of operation

Source: Effluent Guideline Development Document

TABLE 17

SUMMARY OF INVESTMENTS AND ANNUAL OPERATING COSTS

($000's)

	B.P.T.	B.A.T.
Tempered Glass (Typical Plant 37.5 MMSF)		
Investment	81	149
Operating Costs		
Capital	6.5	11.9
Depreciation	4.1	7.5
Operating and Maintenance	11.7	17.9
Energy and Power	1.8	4.8
Total Annual Cost	24.1	42.1
Equivalent Unit Cost (¢/SF)	0.065	0.110
Laminated Glass (Typical Plant 8.0 MMSF)		
Investment	32	115
Operating Costs		
Capital	2.6	9.2
Depreciation	1.6	5.8
Operating and Maintenance	8.0	13.6
Energy and Power	2.4	4.2
Total Annual Cost	14.6	32.8
Equivalent Unit Cost (¢/SF)	0.180	0.410

Source: Effluent Guideline Development Document

V. LIMITS OF THE ANALYSIS

In carrying out our analysis of the economic impact of proposed water pollution controls on the flat glass industry, we have made some general assumptions about the economy. For instance, we have assumed that real growth in Gross National Product will average about 4% per year between 1972 and 1977. We have assumed constant 1973 dollars for all future expenditures, although we recognize that the relative cost of labor, energy, materials and capital may change.

Specifically the conclusions in this study are based on the guidelines as proposed in the effluent guideline development document and the associated technology to meet these limits and the related cost. If the assumptions in deriving these costs or the effluent requirements are changed as to require different technologies, then the conclusions of this study may not necessarily be valid.

We believe that this analysis as presented represents an accurate description of the economic effect of the cost of pollution on this industry. There are other factors operating within the industry such as the replacement of much of the present sheet glass capacity with float that probably are overriding factors in decisions to close certain operations and expand others.